Water Quality Monitoring and Modeling of the North Delta Area

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ABSTRACT

A water quality model was linked to a one-dimensional, Mike 11 hydraulic model of the North Delta area. The hydraulic model was developed to examine flood impacts and areal contributions of sub-tidal, inter-tidal, and supra-tidal habitats available for various restoration possibilities on the McCormack-Williamson Tract.

The water quality model was produced to examine any water quality effects that the restoration might have on the region, the effect of regional scale changes on the restoration area and to produce local boundary conditions for future multi-dimensional modeling of the restoration area.

Temperature and electrical conductivity data were collected at the boundaries of the North delta model to facilitate the calibration and verification of the water quality model. After the model was calibrated, it was used to examine various restoration alternatives on McCormack-Williamson Tract,

1 - INTRODUCTION / BACKGROUND

- Over 90% of tidal wetlands in the Sacramento-San Joaquin Delta have been leveed removing them from tidal and floodwater inundation (Simenstad et al. 2000).
- CALFED has proposed the restoration of some of these damaged systems by reconnecting them to the adjacent rivers and sloughs.
- The Nature Conservancy purchased the McCormack-Williamson Tract (MWT) in 1999 with CALFED funds with a view to restore the tract.
- MWT is located in the northern Sacramento-San Joaquin Delta ~2.4 km downstream of the confluence of the Cosumnes and Mokelumne Rivers. Historically it supported tidal freshwater marsh and floodplain habitats. Located at the upslope fringe of the Delta, the current topography of the interior of the MWT ranges from –0.9 m to +1.5 m in elevation NGVD (Fig. 1).
- It is not known what impact proposed management scenarios will have upon water temperature upstream and downstream of MWT.

2 - OBJECTIVES

- Create a database where water temperature and electrical conductivity have been measured at various points in the North Delta.
- Construct, calibrate and validate a dynamic water quality model, using MIKE 11, to simulate electrical conductivity and temperature fluxes throughout the study area.
- Apply the model to low flow conditions, during the months of August to September, to examine various restoration scenarios and their effect on water temperature
- Provide a quantitative tool for the comparison of various management scenarios on the MWT, with respect to water temperature.

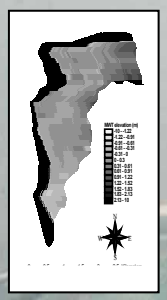


Figure 1. Topography of MWT ranges from –0.9 m to +1.5 m NGVD.

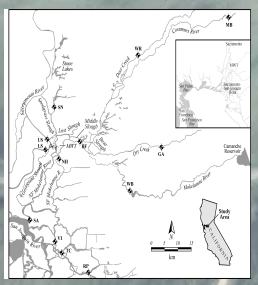


Figure 2. Boundary condition and internal comparison locations used in the model.

3 - WATER TEMPERATURE DATA

- The water and air temperature were collected by UC Davis, while tidal variation (stage) was gauged by the California Department of Water Resources.
- A very weak correlation is present between the tidal exchange and the water temperature at New Hope (Fig. 3a), R^2=0.31 and Bensons Ferry, R^2=0.08 (Fig. 3b) .
- Water temperature has the same trends as air temperature at both New Hope (Fig. 4a) and Bensons Ferry (Fig. 4b) .
- The correlation between air and water temperature at both Bensons Ferry and New Hope is stronger than the correlation of stage and water temperature.
- At New Hope both correlations are stronger than the correlations at Bensons Ferry.

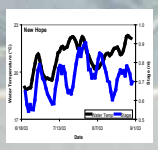


Figure 3a. 24 hr. average of water temperature and 25 hr. average stage data at New Hope (NH).

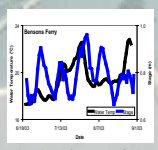


Figure 3b. 24 hr. average of water temperature and 25 hr. average stage data at Bensons Ferry (BF).

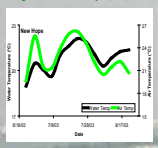


Figure 4a. 5 day average water temperature and 5 day average air temperature at New Hope (NH).

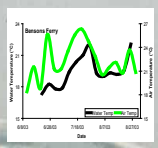
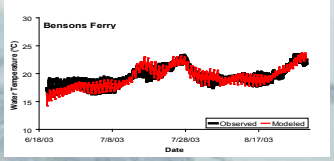


Figure 4b. 5 day average water temperature and 5 day average air temperature at Bensons Ferry (BF).

4 – WATER TEMPERATURE MODEL

- One-dimensional unsteady temperature model based in MIKE 11.
- Six upstream boundary conditions located at Michigan Bar on the Cosumnes River (MB), Wilton Road on Deer Creek (WR), Galt on Dry Creek (GA), Woodbridge on the Mokelumne River (WB), Lambert Road on Stone Lakes Outlet (SN), and above the Delta Cross Channel on the Sacramento River (US). Five downstream boundary conditions located below Georgiana Slough divergence on the Sacramento River (LS), on the San Joaquin River at San Andres Landing (SA), Venice Island (VI), Turner Cut (TC), and and Rindge Pump (RP) (Fig. 2). Two internal comparison locations at Bensons Ferry (BF) and New Hope (NH) used to calibrate and validate model (Fig. 2).
- 83 branches and 674 cross sections from several different sources.
- Model area approximately 1400 square miles.
- Model used to simulate low flow (tidally dominated) conditions during summer of 2003 (early June till late August).
- Model used to simulate potential management scenarios of MWT (Fig. 6).
- Model calibrated at internal points above and below (Bensons Ferry and New Hope) MWT (Fig. 5).



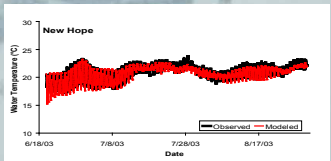


Figure 5. Comparison of modeled results with observed data at both Bensons Ferry and New Hope (Delta Cross Channel open).

5 - SCENARIOS

- Management options include: the removal or breaching of levees, the construction of new levees, and the construction of a notch channel.
- Scenarios were developed based upon input from stakeholders, including The Nature Conservancy, CALFED, California Department of Water Resources, and the Cosumnes Research Group.
- Three scenarios presented: Scenario 1 and 2 shown below in Fig. 6. Scenario 3 examined the effects of closing the Delta Cross Channel (DCC) during the summer with no modifications to MWT.
- The main goal of the scenarios is to improve overall ecological enhancement of MWT

Scenario #1 Scenario #2

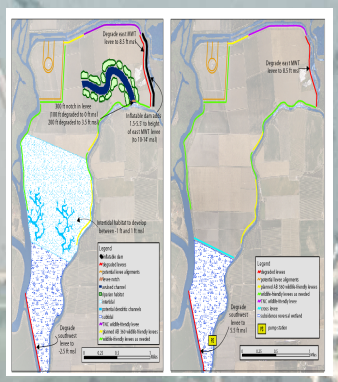


Figure 6. Scenarios 1 and 2 evaluated with the model.

6 - ECOLOGICAL ENHANCEMENT RESULTS

- Scenario 1 does not significantly change water temperature at Bensons Ferry. However, at New Hope there is less fluctuation between the diurnal high and low temperature (Fig. 7).
- Scenario 2 does not change water temperature at Bensons Ferry (Fig. 8) or New Hope because neither degraded levee on MWT overtops.
- Scenario 3 does not significantly change the water temperature at Bensons Ferry. By closing the DCC the daily high values at New Hope are lowered in the beginning of the modeling period, while the daily low values stay the same (Fig. 9). This trend is seen again towards the end of the modeling period.

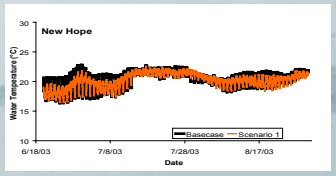


Figure 7. The calibrated model result of New Hope plotted with Scenario 1 modeled.

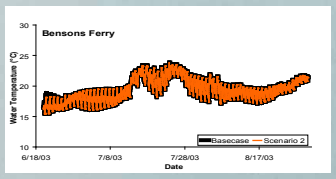


Figure 8. The calibrated model result of Bensons Ferry plotted with Scenario 2 modeled.

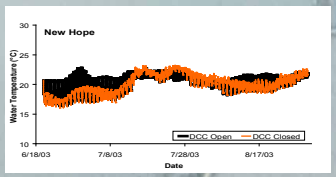


Figure 9. The calibrated model result of New Hope plotted with the Delta Cross Channel closed model.

7 - CONCLUSIONS

- The correlation between the water temperature and stage is not as strong as the correlation between water temperature and air temperature at Bensons Ferry and New Hope.
- Most scenarios do not alter water temperature at Bensons Ferry for the period studied. At New Hope most of the scenarios reduce water temperature.
- With the Delta Cross Channel open a stronger spring/neap water temperature cycle is introduced and a higher diurnal peak temperature is present.
- This model can be applied to different scenarios throughout the North Delta.
- Which scenario is "best" depends on the defined objectives of the project.

8 - ACKNOWLEDGEMENTS

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